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History and Description of the EPA (Environmental Protection Agency) Motor Vehicle Fuel Economy Program

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16. ABSTRACT

This report describes the history of the Environmental Protection Agency's (EPA) fuel economy program from the early 1970's up to and including the 1984 model year. (Beginning with the 1985 model year program significant changes were made to the program to improve the accuracy of the label values. These changes are not addressed in this document.) The fuel economy program is conducted at the Motor Vehicle Emission Laboratory (MVEL) located in Ann Arbor, Michigan.

The energy crisis of the early 1970's brought into focus the need for a reliable source of automobile fuel economy information. Because the EPA was already testing representative vehicles from all manufacturers for exhaust emissions compliance the task of generating fuel economy values on these vehicles was straight forward. Congress gave EPA the responsibility for establishing a mandatory fuel economy program beginning with the 1977 model year. This report describes the methodology used to group a manufacturer's product line into representative subgroups for testing and calculation purposes. The resulting data are used to calculate new car label values, each individual manufacturers's Corporate Average Fuel Economy (CAFE), and any potential Gas Guzzler Tax liability.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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I. History of the Fuel Economy Program

For many years, the fuel economy data were only available on a limited basis from manufacturers and from trade and consumer organizations. Even when available, these data were often of questionable value because of differences in test procedures. The lack of reliable fuel economy data, combined with a growing national concern about our nation's fuel consumption rate, led President Nixon to call for a voluntary fuel economy labeling program for automobiles in his April 18, 1973 energy message to Congress.

At the time President Nixon called for this voluntary labeling program, the EPA was already measuring exhaust emission levels on representative vehicles from every manufacturer which sold vehicles in the United States and publishing these results in the Federal Register.

The fuel economy values for every vehicle tested in the certification program (over 350) were derived from the exhaust emission values measured during the certification program. Thus, the only cost involved was in the calculation procedures. Because of this capability, EPA published the first comprehensive list of fuel economy results along with the exhaust emission results for the 1973 model year in the May 2, 1973 Federal Register (38 FR 10868). The primary purpose of these fuel economy data were to allow a consumer the opportunity to make fuel economy comparisons.

Since the initial 1973 publication of fuel economy data, the need for fuel economy data has expanded to fulfill three specific needs; (1) for vehicle labeling, (2) to determine the corporate average fuel economy, and (3) to determine the liability for a "Gas Guzzler Tax." In the August 27, 1973 Federal Register, EPA published the voluntary protocol for calculating fuel economy values from exhaust emission results. This voluntary protocol also contained a label format which was to be used if the manufacturer chose to display the calculated fuel economy on the vehicle. This program began in the 1974 model year.

The 1974 test procedure used to obtain the data used in the exhaust emission certification program was a "city" type driving cycle[1] and, therefore, the fuel economy result reflected this type of driving pattern. However, the city procedure represented only about 55 percent of the annual

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1. Kruse and Huls, "Development of the Federal Urban Driving Cycle." SAE paper 730553, May 1973.

vehicle accumulation.[2] EPA responded to this concern by developing a second, nonurban driving cycle.[3] As a result, the label program was modified to include the fuel economy results from both the urban and nonurban driving cycles. These fuel economy values were identified by the terms "city" and "highway" and the results from the 1974 model year fuel economy program were published in the November 5, 1973 Federal Register.

In 1975, Congress passed the Energy Policy and Conservation Act (EPCA) which replaced the voluntary fuel economy program with a mandatory program beginning with the 1977 model year. This action required that each vehicle have a label depicting the EPA-determined fuel economy values. This act also required DOE to make available to the public a compilation of these values. This compilation is issued as the Gas Mileage Guide. This Act specified that compliance with the fuel economy standards would be determined on the basis of each manufacturer's average fuel economy for all vehicles produced for sale in the United States. The fuel economy values used to calculate the CAFE for each category (i.e., domestic light-duty, import light-duty, etc.) was to be the average estimated in-use fuel economy. This estimated in-use fuel economy was determined by combining the average city and highway test results, weighted according to the estimated in-use mileage (55 percent city and 45 percent highway--55/45).

In 1978, Congress passed, the Energy Tax Act and the National Energy Conservation Policy Act (NECPA). The Energy Tax Act established a schedule of taxes to be levied on those manufacturers which produce vehicles not achieving certain fuel economy levels. This tax, which is commonly referred to as the "Gas Guzzler Tax," is assessed by the Internal Revenue Service (IRS) and is based on fuel economy data obtained from EPA's emissions and fuel economy programs. NECPA required that any vehicle subject to a Gas Guzzler Tax bear a statement of that tax on the fuel economy label.

From early in the voluntary program and into the mandatory program, data were emerging which suggested that in-use passenger vehicles were not, on the average, achieving the fuel economy levels listed on the label and in the Gas Mileage Guide values. The data indicated that, of the three

2. U.S. Department of Transportation, Federal Highway Administration News Release FHWA 08-74, January 1974.

3. Kruse and Paulsell, "Development of a Highway Driving Cycle for Fuel Economy Measurements," U.S. Environmental Protection Agency, March 1974.

values listed on the labels and in the Gas Mileage Guide, the city value was the closest to the average in-use fuel economy for overall driving. EPA realized that to determine city and highway fuel economy values which are more representative of in-use fuel economy would require substantial change to the EPA's fuel economy program. EPA further realized that a prerequisite to any change would be an in-depth study of data which would take a considerable amount of time. An interim solution was promulgated which specified that, until a better data base could permit a more satisfactory solution, the label and Gas Mileage Guide would use only fuel economy values derived from the EPA city test (termed the EPA estimate). This rule went into effect with the 1979 model year. Even though the combined and highway values were dropped from the information programs, these data were used for the purpose of determining compliance with the CAFE standards. Manufacturers continued using the highway values in their advertising.

Since the promulgation of the interim rule, EPA completed a study of those facets of the current fuel economy program which contribute to the shortfall between in-use and EPA-determined fuel economy levels. The findings of this study were reported to Congress in September of 1980.[4]

II. Current Program Description

The present fuel economy program performs three functions: (1) generates fuel economy values and makes these values available to the public on individual vehicle fuel economy labels and in the Gas Mileage Guide, (2) establishes manufacturers' Gas Guzzler Tax liability based on the general fuel economy label values, and (3) determines manufacturers' compliance with CAFE requirements.

The EPA responsibilities for the above functions are to (1) administer the testing program that generates the fuel economy data used for compliance and public information and (2) determine procedures for calculating fuel economy values for labels, the Gas Mileage Guide, and CAFE. The following is a description of the rules and procedures EPA currently uses to establish the various fuel economy values.

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4. Murrell, "Passenger Car Fuel Economy: EPA and Road," U.S. Environmental Protection Agency, August 1980.

1. Definitions[5]: Before beginning the description of the actual process, it is necessary to present the basic terminology EPA uses in sorting vehicle models and designs. EPA begins by sorting a manufacturer's product line as follows:

MANUFACTURER A

MODEL TYPE (INFORMATION)	BASE LEVEL (CALCULATION)
- CAR LINE	- INTERTIA WEIGHT CLASS
- BASIC ENGINE	- BASIC ENGINE
- TRANSMISSION CLASS	- TRANSMISSION CLASS

VEHICLE CONFIGURATION (TEST)

- ENGINE CALIBRATION (ENGINE CODE)
- TRANSMISSION CONFIGURATION
- AXLE RATIO

A model type is defined as a unique combination of car line, basic engine, and transmission class. EPCA established the term "model type" as the classification of vehicles for the purpose of averaging for CAFE values. EPA defined model types on the basis of vehicle characteristics readily recognized by consumers and important from a fuel economy perspective (e.g., the general name of the vehicle, engine, and transmission).

A car line denotes a group of vehicles within a make or car division which has a degree of commonality in construction. The level of decor or opulence is not considered when establishing a car line. Features such as roof line, number of doors, seats or windows, generally do not distinguish characteristics of a car line. Station wagons are considered distinct car lines from sedans. For example, in the 1980 Gas Mileage Guide, Chevrolet, a division of General Motors Corporation, had listed ten car lines (not including trucks): Corvette, Camaro, Chevette, Monza, Citation, Malibu, Monte Carlo, Impala/Caprice, Malibu Wagon, and Impala/Caprice Wagon. Note that specific model nameplates such as Camaro Sport Coupe and Camaro Berlinetta are covered by one car line (Camaro).

5. The official listing of definitions used in the fuel economy program can be found in 40 CFR 600.002-80.

The basic engine classification includes the number of engine cylinders, engine displacement, and the fuel system. The transmission class is determined by whether it is a manual, automatic, or semi-automatic, along with the number of forward gears (such as three speed or four speed). For example, in the 1980 Gas Mileage Guide, the Chevrolet Citation car line lists four basic engine and transmission combinations: 2.5-liter, 4-cylinder with a manual 4-speed (M-4) transmission; 2.5-liter, 4-cylinder with an automatic 3-speed (A-3) transmission; 2.8-liter, 6-cylinder with a manual 4-speed (M-4) transmission; and 2.8-liter, 6-cylinder with an automatic 3-speed (A-3) transmission.

For testing and calculation purposes, each manufacturer's product line is subdivided into base levels with the term base level defining a unique combination of inertia weight class[6], basic engine, and transmission class. The features of a base level are nearly the same as model type except that weight is substituted for car line. Those features distinguishing a model type are features which can be seen by a consumer. However, in order to more accurately estimate the fuel economy of a particular group of vehicles it is necessary to divide a manufacturer's product line by features which affect fuel economy. The first major division is "base level" and separates the product line on the basis of vehicle weight. Again using the Chevrolet example, a typical base level would be 3,000-pound inertia weight, 2.8-liter displacement, 6-cylinder engine with 2-barrel carburetor, catalyst, and manual transmission.

The next level of division of a manufacturer's product line is called a vehicle configuration. A vehicle configuration is defined as a unique combination of inertia weight class, basic engine, and transmission class (all of which determine a base level) plus engine code, transmission configuration, and axle ratio. Engine Code goes beyond the definition of basic engine by isolating different variations of carburetor, distributor, and other key engine and emission control system component calibrations. Transmission configuration considers more than just manual or automatic and the number of forward gears. It also considers shift calibrations and other design factors that determine the performance of the 3,000-pounds inertia weight with a 2.8-liter, 6-cylinder transmission. An example of a vehicle configuration is: engine, 2-barrel carburetor, engine code A, 4-speed overdrive manual transmission, and 3.23 axle ratio.

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6. Inertia weight class is determined from the curb weight of the vehicle plus 300 pounds (called the loaded vehicle weight). The inertia weight class contains a range of loaded vehicle weights, as defined in 40 CFR 86.029-80.

The most detailed designation of a vehicle is termed a subconfiguration. A subconfiguration is a unique combination of equivalent test weight, road-load horsepower, and other characteristics determined to be significant by the Administrator within a vehicle configuration.

2. Test Procedures: EPA first began obtaining fuel economy values as a byproduct of the exhaust emission tests that is required for emission control certification. The emissions certification procedure includes the operation of test vehicles on a laboratory chassis dynamometer to simulate a 7.5-mile urban trip. The vehicle's exhaust emissions are measured during the procedure for comparison to applicable emission standards. The emission results may also be used to calculate the vehicle's fuel economy during the test cycle. All of the data necessary for the fuel economy calculation for city driving is measured as part of the emission test procedure. The highway fuel economy is determined in a similar manner by using a separate driving cycle that simulates driving on urban highways or similar higher speed, major thoroughfares.

3. Fuel Economy Labeling: EPCA requires that manufacturers have fuel economy labels installed on each car and light truck it produces for sale in the United States. Dealers are required to keep that label on the vehicle until it is delivered to the consumer. Each label must include the following information: (1) the EPA estimated fuel economy of the automobile, (2) the estimated annual fuel cost associated with the operation of the automobile and (3) the range of fuel economy of comparable automobiles. All the information is to be determined according to rules prescribed by the Administrator. EPA is also responsible for specifying, by rule, the form and content of the labels and the manner in which they are affixed.

a. Types of Labels: There are currently two types of fuel economy labels that manufacturers may attach to vehicles. These are the specific label and the general label. A specific label contains the fuel economy of a unique vehicle configuration. EPA only allows the use of the specific labels when there are not yet complete data to calculate a general label value. This usually only occurs early in the model year, before the manufacturer has completed testing of all of the vehicles needed for the general label. A manufacturer cannot use both specific labels and general labels on vehicles within the same model type.

The general label displays a fuel economy estimate for a model type. A model type can contain many unique vehicle configurations. Thus, the model type fuel economy value is calculated from fuel economy data collected from many vehicle configurations. This calculation, which is described below, is an average of the vehicle configuration data, taking into account the anticipated sales of each vehicle configuration. That is, it is a sales-weighted average. The general label values are determined once for each model year, and are not changed during that model year. This was done as a cost and resources saving measure over updating label values periodically or in case of new data from product changes.

b. Determination of the Label Value: The minimum amount of data required for a general label value calculation is that each base level must be represented by at least one vehicle configuration test value. If there is more than one configuration test value within a base level, the base level fuel economy is determined by a sales-weighted average of the fuel economies of all the tested configurations. The base level fuel economy values within each model type are then harmonically averaged to obtain the model type fuel economy values. These are the fuel economy values printed on the vehicle labels. Figures 1 and 2 are illustrations of the calculation process.

4.4 CAFE Compliance: In 1975, the newly enacted EPCA mandated a 100 percent improvement in the average automobile fleet fuel economy from the base year of 1974 to model year 1985. EPA was charged with the responsibility for calculating the fuel economy values and the Department of Transportation (DOT) is authorized to assess penalties. Specifically, EPCA requires that the sales-weighted average fuel economy of each manufacturer's production of new car or light truck fleet (the CAFE) meet minimum fuel economy values each year. These CAFE standards increase in stringency with each new model year. (The 1978 CAFE standard was 27.5 mpg.) CAFE standards for light trucks began with the 1979 model year and are different than those for cars.

If a manufacturer fails to meet the CAFE standard for a given model year, DOT is authorized to assess the manufacturer a charge of $5 per vehicle manufactured for each one-tenth mpg that the CAFE is over the standard.

FIGURE 1. Example of Configurations Combining into a Base Level

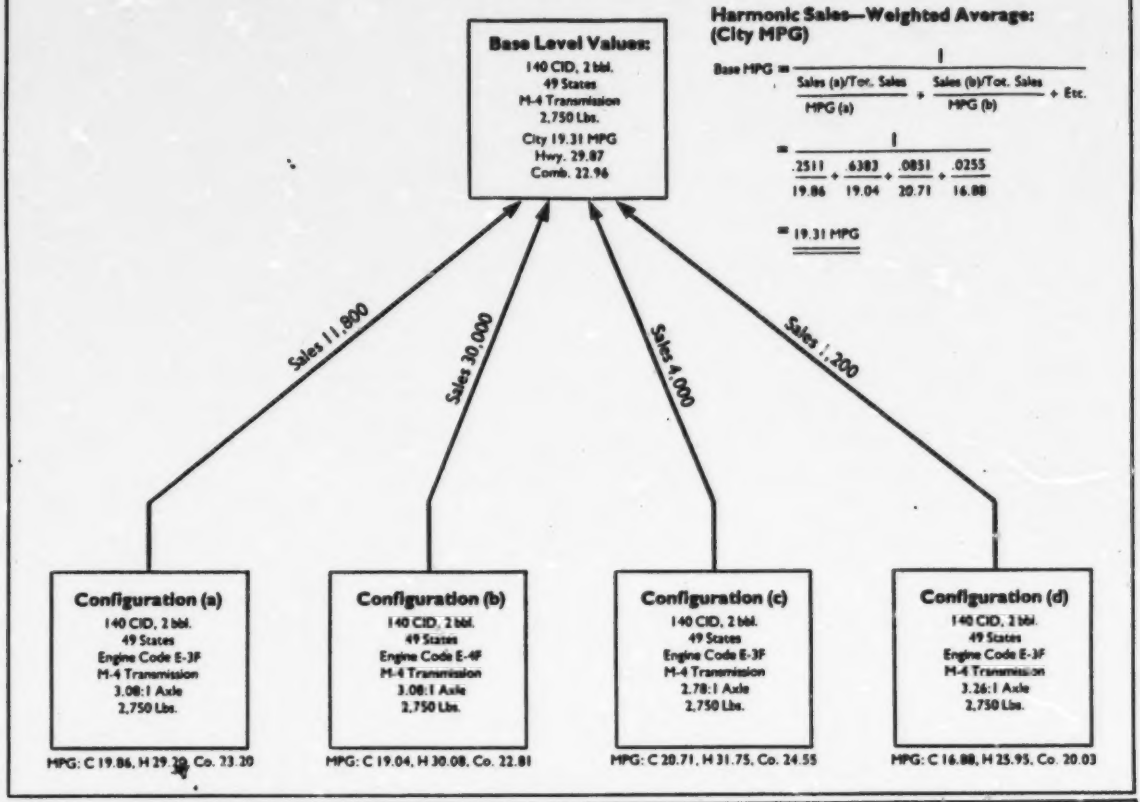
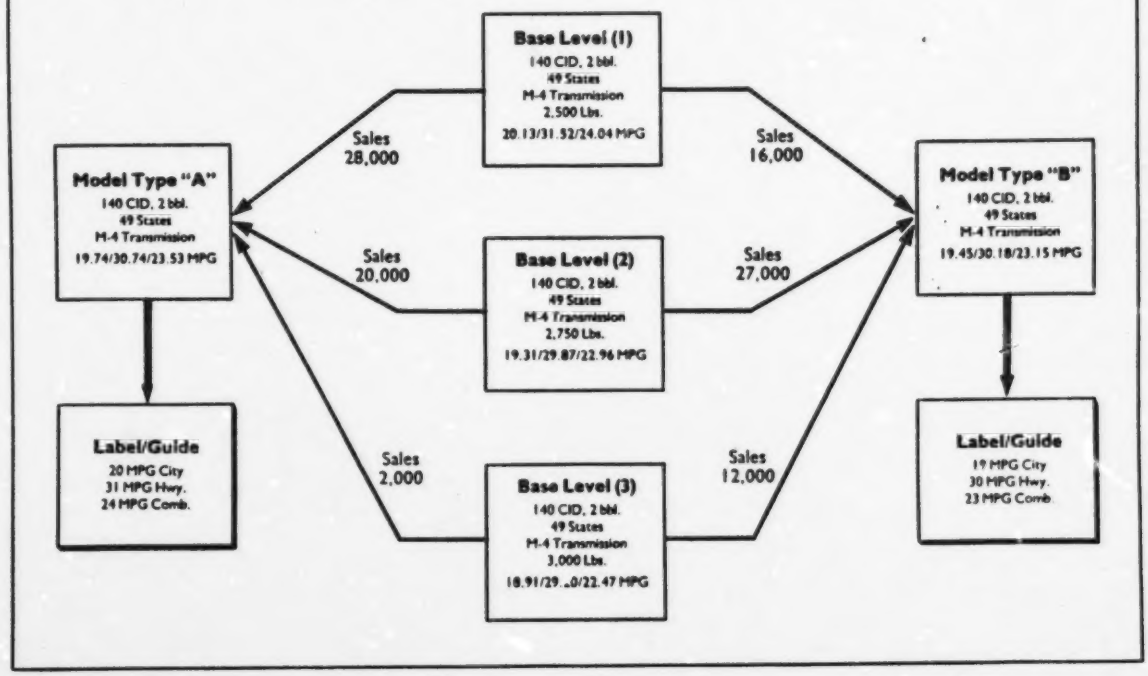


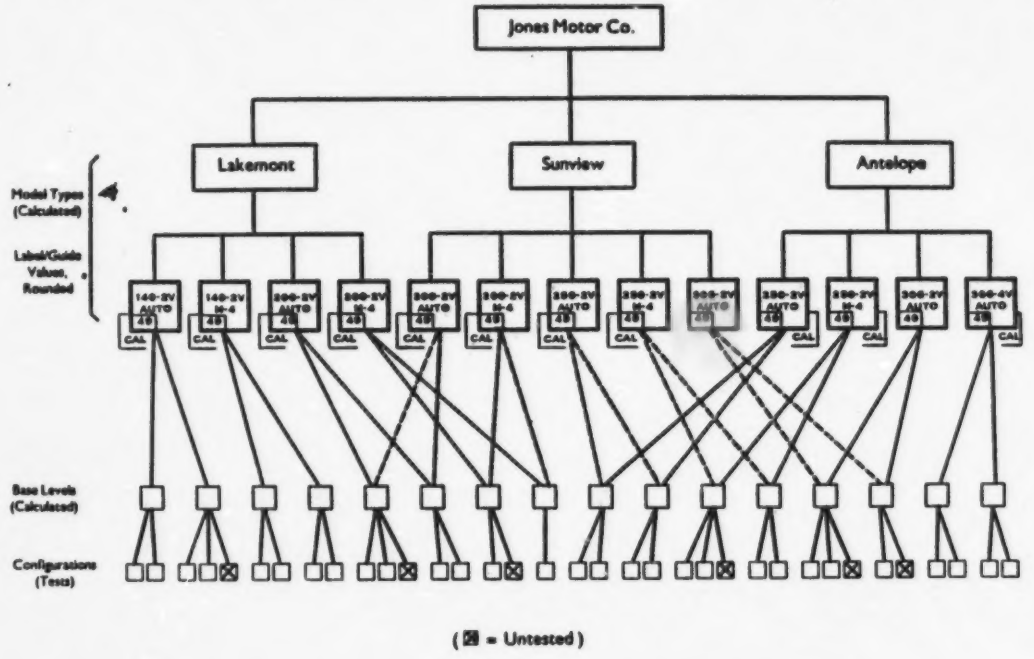
FIGURE 2. Example of Base Levels Combining into Two Model Types



EPCA requires that EPA calculate CAFE values based on the weighted average of both the EPA urban driving cycle and the EPA highway driving cycle. This average result of the two tests (called the "combined") is weighted at 55 percent urban driving and 45 percent highway driving. The following is a summary of how EPA determines CAFE values:

a. Data Requirements: The data base EPA uses to calculate each manufacturer's CAFE value includes all of the data used to calculate general label values. However, the CAFE data base generally includes more data. The minimum data requirement to calculate label values is data from one vehicle configuration in each base level. The minimum requirements for CAFE compliance is more extensive. A pictorial example of the calculation process is shown in Figure 3.

FIGURE 3. Fuel Economy Calculation Flow: from Test Data through Corporate Average



The final CAFE value for each manufacturer is based upon actual fleet sales figures for that model year. (As with general label values, the CAFE is a sales-weighted average.) However, the manufacturers wanted EPA to establish a protocol that would provide a mid-year preproduction rather than establishing minimum data requirements to apply to an actual sales at the end of the model year. As a result of the manufacturers request, EPA established minimum requirements for a preliminary CAFE calculation earlier in the model year. The preliminary CAFE calculation uses projected fleet sales.

The preliminary CAFE currently serves several functions. First, it establishes early in the model year CAFE data requirements. Second, it estimates each manufacturer's CAFE as a check against the CAFE standards. Third, it establishes the data needs to cover changes manufacturers make to their product lines during the model year.

As with the general label values, the CAFE calculation uses base levels to group data from vehicle configurations. For the preliminary CAFE calculation, the manufacturer must supply fuel economy data from the highest projected selling configurations in a significant base level (those base levels with over 1 percent of the manufacturers' total sales) until a minimum 90 percent of the sales for that base level are represented. For nonsignificant base levels (those with less than one percent of the manufacturer's total sales), the manufacturer must supply fuel economy data from the vehicle configuration with the larger projected sales within the base level.

The manufacturer must submit the preliminary CAFE calculation to EPA within 10 days of when EPA makes available the range of fuel economy values for comparable vehicles, or within 30 days of the introduction of the manufacturer's first model type. EPA makes no requirement on when the manufacturer must calculate the preliminary CAFE before submitting it. Thus, to a limited extent, the manufacturer has control over what data to include in the preliminary CAFE. The manufacturer will have satisfied the preliminary and the final CAFE data requirements for the year provided the manufacturer does not make any changes to the product line during the model year. This is discussed below.

b. Production Design Changes (Running Changes): Most manufacturers make changes to their product lines during the model year. These changes may include the addition of new models, or design or specification changes to existing models. EPA calls these changes running changes. Manufacturers make their running changes for a variety of reasons. Among the reasons are cost savings (e.g., use cheaper parts or eliminate

unnecessary components), improvements to driveability, improvements to fuel economy, reductions in emissions, and expansion of option availability. Obviously, not all of these changes have the same effect on fuel economy. Under the provisions of 40 CFR Part 86, manufacturers generally cannot make changes or additions to their product line during the model year unless EPA agress that the emissions certification is still valid. Thus, EPA may require manufacturers to test vehicles to prove that the running change does not cause the affected vehicles to exceed emission standards. EPA usually tries to select running change test vehicle designs that will likely exhibit the worst emissions. Whenever possible, EPA also tries to fulfill the fuel economy data needs at this time in order to save additional testing for fuel economy under 40 CFR Part 600 (below).

40 CFR 600.507 sets minimum fuel economy data requirements for running changes. These are commonly known as supplemental requirements since the data are not required until after the approval of the running change. For significant base levels, EPA requires additional running change fuel economy data for only those running changes which create new vehicle configurations. Manufacturers must submit these fuel economy data for only the projected highest selling new vehicle configurations created by the running change. For nonsignificant base levels, EPA does not require additional data unless the cumulative total projected sales of all base levels added since the last calculation of the manufacturer's average fuel economy is 3 percent or more of the manufacturer's current total applicable projected automobile or truck sales. The manufacturer must recalculate its preliminary CAFE when the total projected sales of added nonsignificant base levels reaches or exceeds 3 percent, or when a running change adds a new significant base level. The new calculated preliminary CAFE can be different because the calculation is based upon all available data including data from the top 90 percent of the vehicle configurations of the base level. The latest sales projection may indicate that additional data are required to represent the present 90 percent.

Related to the running change, manufacturers sometimes make another type of change during the model year. This change, called a field fix, is intended to make changes to vehicles already sold and in-use. Manufacturers usually make these changes to fix driveability problems such as spark knock. These changes can affect fuel economy, emissions, or both. Manufacturers need not submit emission data and gain EPA approval for field fixes, but the manufacturers are still responsible if the field fix causes vehicles to exceed emission standards. For this reason, manufacturers often request EPA approval of field fixes that may affect emissions. There are currently no fuel economy data requirements for field fixes.

c. Test Vehicles: EPA is allowed to use fuel economy data generated for emission certification testing in the CAFE data base. This includes data from all emission-data vehicles (vehicles, which run 4,000 miles with production calibrations) used in the original preproduction certification process, and data from emission-data vehicles required for running change approvals. In addition, under 40 CFR 600.509, a manufacturer is allowed to submit additional fuel economy data at its option.

Because the Clean Air Act requires that vehicles be certified as conforming to emission standards before they are sold, manufacturers must build special preproduction test vehicles for certification. These are called prototype vehicles. EPA requires that these prototype vehicles be representative of the production vehicles that manufacturers will actually sell. Virtually all emission-data vehicles are prototype vehicles, and these are often reused for emission testing to gain running change approvals. The regulations accept the use of any emission-data vehicle as a fuel economy data vehicle.

The rules for test vehicles to be used for fuel economy testing are very flexible. Manufacturers are allowed to reconfigure vehicles for particular tests. This means that the manufacturer can change components on a test vehicle to make it represent a particular configuration from which they need these data. They are also allowed to use development vehicles, company fleet vehicles, or vehicles from many other sources in addition to the emission program. Manufacturers may continue to obtain fuel economy data from test vehicles that have accumulated up to 10,000 miles. All of these flexibilities were devised to save manufacturers significant test vehicle costs in light of the number of tests EPA requires for fuel economy. Thus, manufacturers can use vehicles from many sources, use them repeatedly, and are allowed 10,000 miles to extend the testing life of the vehicle.

d. CAFE Calculations: The method EPA uses to calculate preliminary CAFE and final CAFE values begins the same as the calculation of model type values. However, the CAFE calculations go one step further. Once the model type values are determined, the CAFE value is the sales-weighted, harmonic average of all of the manufacturer's model type values. For the preliminary CAFE calculation, the projected sales are used, and for the final CAFE calculations, the actual sales are used.

5. Gas Mileage Guide: As mentioned earlier, EPA is responsible for generating the fuel economy values that appear in the Gas Mileage Guide (Guide). The contents of the Guide, aside from the fuel economy values, are established by both EPA

and the Department of Energy (DOE). DOE is responsible for the printing and distribution of the Guide. EPA regulations (40 CFR Part 600, Subpart E) require that vehicle dealers display and make available the Guide. However, since the Guide is prepared by the Federal government the contents are not governed by regulation.

Vehicles are listed in the Guide according to car line or truck line class. EPA determines these classes according to interior volume for cars and carrying capacity for trucks and vans. The general car classes currently listed in the Guide are: two-seater, minicompact, subcompact, compact, mid-size, and large.

The fuel economy of vehicles listed in the Guide are the same fuel economy values that are on the general labels. These provide consumers with a convenient comparison shopping guide for new vehicles. Since the Guide and the general model type labels are the same, selecting vehicles from the Guide gives as much fuel economy information as comparison shopping in the dealer show rooms.